

PROBLEM SELECTION STATEMENT
FOR
LINE PROJECT FS-INT-1603
WATERSHED PROTECTION AND REHABILITATION

The project titled "Watershed Protection Requirements and Rehabilitation Measures to Reduce Flood Runoff, Erosion, and Sediment from Deteriorated Rangelands and Grazed Forested Areas" is headquartered at Logan, Utah. Its research objectives are: (1) To develop watershed protection requirements and flood and erosion hazard criteria for mountain range and grazed forest land; (2) to improve methods of restoring plant cover, soil stability, and acceptable infiltration to depleted range and grazed forest watersheds; and (3) to determine the effects of various rehabilitation treatments and management practices on flood and erosion hazard potentials. These research objectives resolve into three specific research missions: (1) Development of protection requirements and erosion hazard criteria for major soil-vegetation-climatic complexes; (2) development of feasible rehabilitation treatments for deteriorated watersheds that defy rehabilitation by present treatments; and (3) development of criteria by which the hydrologic functioning and stability characteristics of watersheds under different uses can be predicted.

Problem Situation

Ten major range or grazed forest types cover almost 200 million acres in the Station territory. Eight of these types comprise about 118 million acres of mountainous terrain. These types provide essential forage for about 2 million domestic livestock and 2 million big game animals. These lands are a vital source of water for agricultural, industrial, and municipal uses. Grazed forest lands produce a small portion of the annual timber harvest. Recreation on these lands is increasing at a phenomenal rate. Many of these activities have led to deterioration of the vegetation and soil resources that is reflected in reduced productivity, increased frequency and intensity of flooding, and lower quality streamflow from sedimentation.

Pertinent conditions and relations on the eight important mountainous range types of primary concern to this project are summarized below

1. High-elevation grass-forb type. This type, occupying about 4.1 million acres, presents the most difficult problems with respect to protection, rehabilitation, and management. It occurs in the highest precipitation zones, yields the greatest amount of runoff, and has a severe climate. Heavy summer grazing for a century or

less has depleted vegetation and compacted soil. In Region 4, one-third of the high-elevation grass-forb range still retains potential for recovery under proper management; one-third needs reseeding and proper management; and the remainder requires rehabilitation treatments of a more intensive nature than the conventional ones. Deterioration of this type is locally serious in Region 1, but much more widespread in Region 4.

2. High-elevation sagebrush grass type. About 2.8 million acres with a climate similar to that of the drier sites of the grass-forb range are covered by this type. Portions are deteriorated, but it has much more potential for rehabilitation than the deteriorated grass-forb type because of the protection afforded by sagebrush. Rehabilitation and conversion to grass-forb range holds promise for enlarging the production and extent of the grass-forb type. Such conversion may also increase water yields. Protection and rehabilitation problems are not as great on this type as on the grass-forb types.

3. Aspen-herbaceous type. About two-thirds of this type, comprising almost 3 million acres, occurs in Utah and is second in importance as a high-elevation range type only to the grass forbs. This type, except in localized areas, has suffered less widespread vegetative deterioration and erosion, and enjoys a less rigorous climate, with fairly deep and fertile soils, than the two aforementioned types. These circumstances enhance the success of management practices and rehabilitation treatments as required.

4. Coniferous forest-range type. This type of rangeland occupies about 14.4 million acres and is highly variable in elevation and latitude, but is not subject to such climatic extremes as the above types because of protection afforded by the canopy against direct solar radiation, raindrop impact, desiccating winds, etc. These lands produce significant water yields and, normally, only small amounts of sediment directly attributable to grazing; although local areas having suffered denudation are high sediment producers. With two major exceptions, protection and rehabilitation requirements are of less urgency than most other types. One exception is occurrence of increased magnitude and frequency of rain-on-snow or rain-on-frozen ground floods along the east Sierra Nevada, where annual flood damages in the Reno, Nevada area alone exceed \$100,000. Destruction of vegetation by overgrazing, burning, and unregulated timber harvesting has resulted in accelerated erosion, reduction of the depth of soil, and loss of water storage capacity. Flash floods from high-intensity storms have been intensified by the development of hydrophobic surface soils under waxy, fatty, or resinous litter of the chaparral cover. The other exception occurs in the Idaho Batholith, where overland flow or subsurface flow produce copious quantities of sediment from highly unstable slopes.

5. Mountain-brush type. Of the approximate 4.7 million acres of this type, about two-thirds occur in Utah in a zone between the aspen-herbaceous and pinyon-juniper or low-elevation sagebrush-grass types. Urgency for protection and rehabilitation research is not great because, except on some private lands, this type has not been damaged severely. Much of this type occupies slope faces between drainages, consequently overland flow and sediment are dissipated before reaching stream channels.

6. Bunchgrass-range type. Originally a type affording high-quality forage of wheatgrass, fescues, bluegrasses, needle grass, and giant wild rye, heavy grazing and fire have greatly reduced the perennial bunchgrasses which have been replaced by annual weeds and grasses of inferior forage quality and watershed protection. High-intensity storms occurring on bunchgrass ranges having granitic soils often produce damaging sediment-laden floods. Scarce moisture supply and high temperatures limit rehabilitation by conventional means.

7. Pinyon-juniper type. Vast acreages of this type occur throughout the Station's territory, but principally in Utah and Nevada. Much of it has been grazed excessively; and this practice, in conjunction with steep topography, thin soils, and limited precipitation, combine to make difficult problems of management and rehabilitation. Where grasses or palatable shrubs have been thinned by excessive grazing, nonsprouting pinyon and juniper dominate, with little or no ground cover between crowns. Soil erosion and gullyng are pronounced and, often, only an erosion pavement remains. The extent of this type and its role as a sediment producer with deleterious effects on water quality, place it in high priority for research to develop methods for rehabilitating, protecting, and managing it.

8. Low-elevation sagebrush type. This type occupies about one-fourth of the Station territory, and is commonly situated on deep, fairly fertile soils, often of alluvial origin. It provides substantial winter and spring-fall forage, and eradication of sagebrush to favor grasses is a common practice. As a whole, this type is not a serious flood or sediment-producing area. Management and rehabilitation methods exist for much of this rangeland.

Project Mission Problems

This brief resume of range types and conditions suggest priorities in the order listed below for watershed protection, rehabilitation, and management research: high-elevation grass-forb (Utah, Idaho, and Montana); coniferous forests (Nevada); pinyon-juniper (Utah); and bunchgrass ranges (Idaho).

The numerous range types situated on different soils derived from a variety of geologic materials, when considered in light of variations in topography, climate, and kinds and degrees of past grazing use, result in a large number of hydrologic complexes with respect to disposition of water and soil stability. To develop methods and techniques for the protective management and utilization of these resources requires extensive sound knowledge of the inter-relations of the environmental parameters of the major soil-vegetation-climatic complexes. General criteria for rehabilitating and protecting some range sites have been developed, but they need to be expanded and refined.

Harsh, deteriorated sites still defy rehabilitation by conventional methods. Underlying limiting factors need to be defined, methods to alleviate or circumvent limiting factors need to be devised, and more fundamental knowledge of physiological tolerance limits of plants must be sought. Eventually, management criteria to provide minimum required watershed protection under continued resource use must be devised to effectively control flood runoff and erosion.

Basic knowledge deficiencies and needs for improved management practices indicate that seven problems comprise the research mission of this project. They are:

Problem No. 1. Watershed protection requirements for the important soil-vegetation complexes. An urgent need exists for identifying and quantifying, singly and in combination, the effects of vegetative, soil, topographic, and climatic factors on infiltration and soil stability. Based upon relations established, hydrologic behavior and soil stability of watersheds may then be predicted, and protection requirements for different kinds and levels of use can be formulated. Present protection requirements already developed for some rangelands need more precise definition because rules-of-thumb are inapplicable to all conditions. Such refinement is needed to reflect more adequately the role of plant cover characteristics and soil properties in site-by-site control of overland flow and accelerated soil erosion.

Problem No. 2. Erosion hazard criteria for major soil-vegetation-climatic complexes. Land managers can do little to alter the geologic, physiographic, or climatic conditions encountered on range or grazed forest lands. However, they need to know the manner and degree that these unalterable factors influence hydrologic functioning and soil stability under different vegetation, soils, and land uses. In turn, managers need to know the responses of lands to various levels of management in respect to erodibility. Consequently, the development of criteria to identify and quantify

inherent and induced soil erodibility characteristics of rangelands is a high-priority problem for research.

Problem No. 3. Management practices and treatments to reduce rain-on-snow flood damages. A substantial portion of flood control along the east Sierra Nevada must be provided by major regulatory reservoirs; however, such structures do not control onsite erosion, overland flow, rapid seepage flow, or channel degradation in upstream watersheds. Adequate revegetation to improve soil stability, increase infiltration, insulate against soil freezing, improve soil-water storage, and delay flashy runoff will ameliorate this problem. Minor engineering structures, e.g. contour trenching or soil pitting, may create a more circuitous routing of runoff, thereby disrupting the rapid synchronization of peak discharges. Principles derived from research along the Sierra Nevada will be applicable to other known frozen soil or rain-on-snow problem areas in the Intermountain area.

Problem No. 4. Identify and quantify environmental factors that limit establishment and growth of vegetation on harsh sites. Numerous harsh sites have resisted conventional attempts to establish sufficient plant cover to provide effective control of overland flow and erosion. To develop successful revegetation techniques for these areas requires better understanding of the physiological relations between plants and the micro- and macroenvironmental factors of harsh sites. Among the kinds of knowledge needed are the limits, duration, and magnitudes of variation of such factors as soil temperature and moisture stress, air temperatures at and near ground surface, humidity, radiation, wind movement, and evaporation.

Problem No. 5. Physiological tolerance limits of selected plant species for revegetating harsh sites. The availability of adequate soil moisture is one of the most critical factors in plant survival and growth. Whether a plant can survive soil moisture stress depends upon the plant internal water potential that can be maintained under given conditions of soil-water potential and atmospheric evaporative demand. Successful rehabilitation of harsh sites, therefore, is partially contingent upon a better understanding of the soil-plant-atmosphere-water potential relations. Thus, research to determine physiological tolerances of different vegetation to different kinds and ranges of harsh site factors, when combined with research on harsh site environmental factors, provides a sound approach to harsh site restoration by matching plants to sites.

Problem No. 6. Development of economically practicable rehabilitation treatments. Such rehabilitation measures as contour trenching, reseeding, modified management systems, and gully control structures have been applied successfully to areas near high-value

urban developments. A great need exists for equally positive, but less expensive, treatments adaptable on a broader scale to remote headwater areas. Past successes have been due, in part, to the natural recovery potential inherent to the treated sites. On the so-called harsh sites, the natural recovery potential is exceedingly low, and drastic innovations in present measures are required. Numerous rehabilitation failures can be attributed to poor techniques and the vagaries of weather; others to the lack of knowledge about physiological requirements or tolerance limits of the species selected for revegetation. As matching knowledge of harsh site limiting factors and physiological tolerance limits of plant species become available, successful application of this knowledge will require equally important knowledge of the techniques and methods for establishing plant cover, including seedbed preparation, time, rate, and depth of planting, mulching, fertilizing, mechanical structures, and other treatments, as necessary.

Problem No. 7. Synthesis and evaluation of protective watershed management systems for improving soil stability and flood control. The numerous resources derived from range and grazed forest watersheds contribute significantly to the regional economy and the West's "way of life." Grazing practices that represent proper use management need to be determined, both on native and rehabilitated ranges presently in satisfactory condition. Continuing progress in developing rehabilitation measures, coupled with a better understanding of the functioning of mechanical structures and improvements in or introduction of more desirable plants, makes systematic synthesis of current knowledge a necessity to insure rapid application of improved practices. Evaluations are needed of the persistence of beneficiary results accruing from watershed restoration measures. More exact determinations must be made of the potential of watershed improvement that can be realized by management alone. Economics of rehabilitation must be considered and innovations in watershed treatment must be evaluated.

Problems Selected for Study

All seven of the foregoing problems have been selected for study, as opportunity permits, with the realization that full-scale attack cannot be implemented in all of the major range and range-related forest complexes. Nevertheless, all these problems are interrelated and action on one complements action on the others. Utilization and enjoyment of resources derived from range and grazed forest watersheds continues at a dynamic pace. Forage production is basic to the livestock industry; and, although curtailments have been effected in stocking in certain areas, the livestock industry continues strong. The need for abundant water supplies continues

unabated, and serious shortages are forecast within the next 15 years in this area. Recreational use of these lands is increasing at phenomenal rates and promises to continue. Thus, the importance of a broad attack is justified by the dependence of a dynamic population on these lands for a variety of resources.

Work on the development of watershed protection requirements and erosion hazard criteria will be concerned primarily with high-elevation grass-forb ranges on sedimentary-derived soils in Utah and Montana and on granite-derived soils in Idaho. It will also be concerned with the coniferous forest type on andesitic and granitic soils on the east side of the Sierra Nevada Mountains in Nevada and California. Part of this work is already underway in Utah, Idaho, Montana, and on the Sierra Nevada east slope. It is planned to intensify the research efforts on these problems in Idaho because of increasing concern about erosion hazards and sediment-production potentials of extensive areas of highly erodible, granitic-derived soils on steep topography.

Research to develop management practices to reduce rain-on-snow floods, already underway on the Sierra Nevada east slope in cooperation with the University of Nevada, will be continued and intensified as facilities permit. Initial efforts are concerned with the occurrence, duration, and kinds of soil frost encountered in various chaparral, timber, and open-herbaceous types, and with the effects of various kinds and degrees of soil freezing on infiltration, overland flow, and erosional processes during winter rain or rain-on-snow flood-producing climatic events. Investigations of these relations will eventually be extended to other localities in the Station territory, where soil freezing periodically contributes to aggravation of winter floods.

Research on the problem of developing efficient methods for restoring protective cover on harsh sites will be focused on harsh sites of high-elevation grass-forb range types on sedimentary-derived soils in Utah and granitic-derived soils in Idaho, and on harsh sites of the mixed coniferous forest-brush types of the east side Sierra Nevada. Relatively little is known about the ranges of variability and magnitude of harsh site factors that may be limiting to plant establishment and development or of the duration of their limiting effects. Research sites will include, not only the high-elevation grass-forb and coniferous forest-brush complexes, but also the pinyon-juniper type in Utah and the bunchgrass type in Idaho.

The problem of synthesizing and evaluating watershed management practices for improving soil stability and flood control on range-lands constitutes a synthesis and appraisal phase of research,

wherein the effectiveness of solutions to the first six project mission problems are tested and evaluated in new or modified management systems.

Coordination

Common interests and related objectives exist between watershed management, range management, and wildlife habitat management. To a lesser degree, certain objectives related to development of erosion hazard criteria are of common interest to watershed management and engineering research. The assigned missions of INT Projects 1602, 1605, 1701, 1702, 1703, 1704, 1801, 1802, 1803, and 3701 need to be considered as they relate to the mission of this project.

Project 1602 is concerned with stabilization of soils, and vegetation is one of the chief tools to be relied upon. Determination of granitic soil erosion hazard criteria and the selection and testing of the adaptability and efficacy of plants to restore vegetative cover should be coordinated closely between this project and Project 1603. Projects 1701 and 1801 are concerned with livestock range and wildlife habitat management research on the same granitic soils in Idaho. Coordination of efforts between Project 1603 and these two projects is essential in connection with development of range-watershed protection requirements and erosion hazard criteria, development of techniques and methods for vegetative rehabilitation of deteriorated granitic-soil ranges, and development and evaluation of safe management practices.

Project 1605 is concerned with research to improve water yields from the mountain-brush and aspen-herbaceous types in Utah. Although these two types do not require immediate protection and rehabilitation research by Project 1603, the methods of management to improve water yields from these two types, as developed by Project 1605, will require careful scrutiny and evaluation by Project 1603 with respect to their runoff and erosion control capabilities.

Project 1702 is concerned with management of Northern Rocky Mountain grasslands for livestock grazing purposes. Project 1704 is concerned with the management of high-elevation mountain herblands and aspen ranges. Since the high-elevation grass-forb ranges comprise one of the highest priority types with which Project 1603 is concerned in regard to development of protection requirements, erosion hazard criteria, rehabilitation of harsh sites, and synthesis and evaluation of management systems, there are needs for close coordination between Project 1603 and these two projects in the

areas of effort indicated. Where these areas of Project 1603's research effort involve forest land adjacent and related to grass-forb ranges, coordination should be effected with Project 1802, which is concerned with forest wildlife habitat management in the Northern Rocky Mountains.

Project 1803 is concerned with research on game-range restoration methods and wildlife-livestock management relations. In connection with it and the browse improvement project, Project 1603 can be expected to rely quite heavily on both existing and future work involving selection and establishment of shrubs and forbs that might be useful in rehabilitation efforts.

As the work of Project 1603 progresses into pinyon-juniper ranges, coordination will need to be established with Project 1703, which is concerned with research on the management of salt-desert-shrub, sagebrush-grass, and pinyon-juniper ranges.

Project 3701 is concerned with the development of engineering systems for steep-mountain forestry, and has an interest in stability characteristics of various soils in relation to logging and the development of forest transportation systems. Project 1603 also has a vital interest in stability characteristics of various soils in relation to the development of erosion hazard criteria. These mutual interests indicate the necessity for close coordination between these two projects to insure that research efforts on soil stability behavior are complementary.

Care must be exercised that technical information and counsel are exchanged between Project 1603 and Agricultural Research Service personnel who are involved in seeding and plant adaptability tests on range complexes of mutual interest to both groups.

Financing

The gross budget of Project 1603 in F.Y. 1968 is \$124,407, including allocations to Reno and Ephraim. This provides five full-time scientists, one permanent technician, and temporary summer assistants. The level of financing is rather austere. Long-term plans include additional scientists and complementing technicians.

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